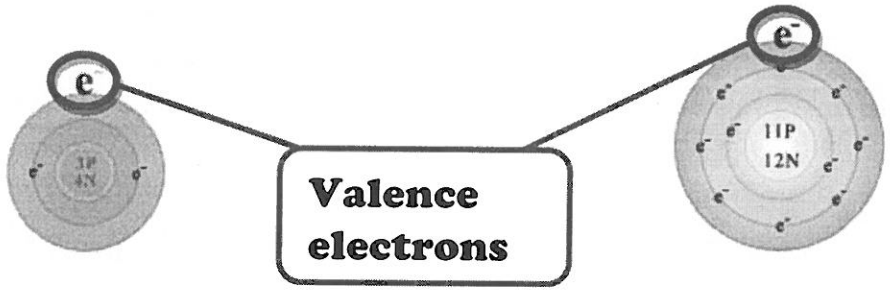
**Chemistry** Mr. Rodrigo

Name _____ Period _____

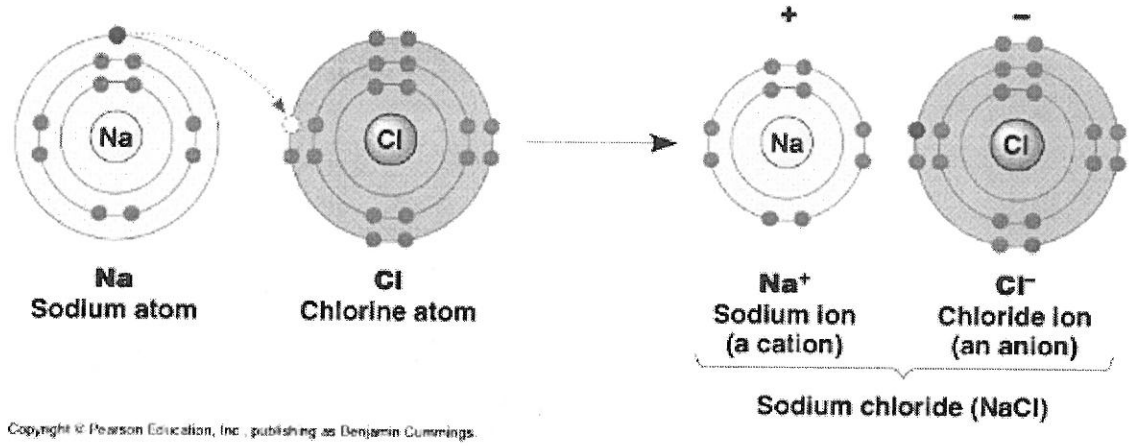
Worksheet Ionic bonding, Lewis dot structure, Covalent bonding, Molecular structures

**Valence electrons**: When an atom undergoes a chemical reaction, only the outermost electrons are involved. These electrons are of the highest energy and are furthest away from the nucleus. These are the ***valence electrons***. For the main group elements, the valence electrons are in the orbitals *s (this orbital holds up to 2 electrons)* and *p(this orbital holds up to 8 electrons).*




## IONIC BONDING

Ions are formed where electrons are transferred from the valence shell of one atom (usually a metal) to the valence shell of another atom (non-metal) so that both end up with Noble Gas configurations. Assume, in the first instance, that compounds between reactive metals and reactive non-metals will be ionic.






1. Ionic bonds form between metals and non-metals.
2. In naming simple ionic compounds, the cation is always first, the anion second (e.g., sodium chloride).
3. Ionic compounds dissolve easily in inorganic/water and other polar solvents.
4. In solution, ionic compounds easily dissolve.
5. Ionic compounds tend to form crystals with high melting temperatures.

6. When naming ionic compounds, write the cation first and the anion second; use prefix to indicate the number of atoms of each type present in the compound.

7. Fill in the following chart.

| Element | Number of valence electrons | # of electrons gained or lost to fill outer energy level | Charge |
|---|---|---|---|
| Sodium | 1 | 1 | +1 |
| Chlorine | 7 | 1 | -1 |
| Beryllium | 2 | 2 | +2 |
| Fluorine | 7 | 1 | -1 |
| Lithium | 1 | 1 | +1 |
| Oxygen | 6 | 2 | -2 |
| Potassium | 1 | 1 | +1 |
| Magnesium | 2 | 2 | +2 |
| Phosphorous | 5 | 3 | -3 |
| Aluminum | 3 | 3 | +3 |

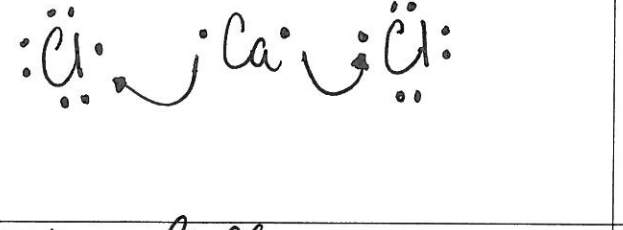
8. For each of the following elements, draw the Lewis dot structure and arrows showing the transfer of electrons. After, write the chemical formula and systematic name.

| a. Sodium + Chlorine | g. Potassium + Iodine |
|---|---|
|  |  |
| Formula NaCl | Formula KI |
| Name Sodium chloride | Name potassium iodide |
| b. Magnesium + Oxygen | h. Calcium + Sulfur |

Formula MgO

Name magnesium oxide

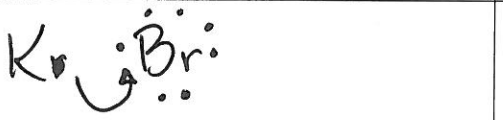
c. Calcium + Chlorine



Formula $CaCl_2$

Name Calcium dichloride.

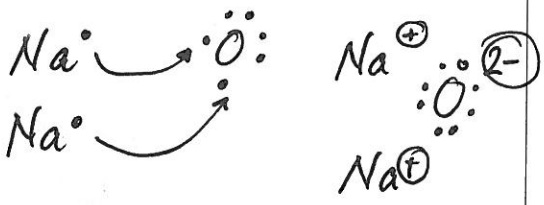
d. Potassium + Bromine



Formula KBr

Name potassium bromide

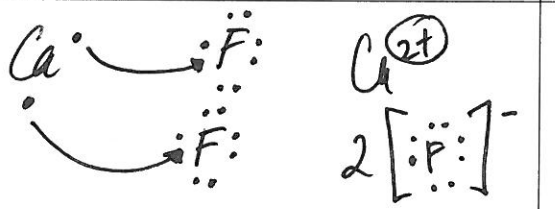
e. Sodium + Oxygen



Formula $Na_2O$

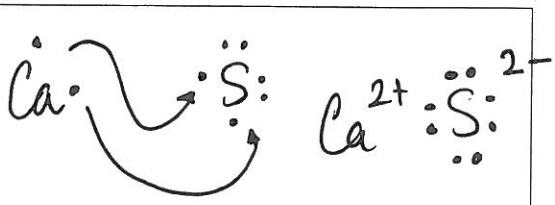
Name disodium oxide.

f. Calcium + Fluorine



Formula $CaF_2$

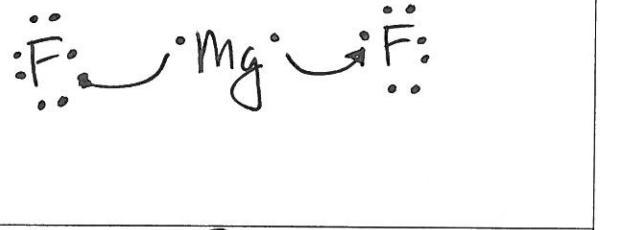
Name Calcium difluoride.



Formula CaS

Name calcium sulfide

i. Magnesium + Fluorine



Formula MgF

Name magnesium difluoride

j. Potassium + Oxygen

Formula

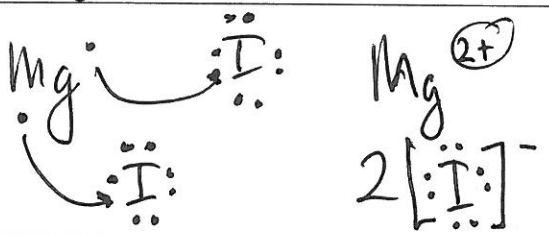
Name

k. Aluminum + Chlorine

Formula $AlCl_3$

Name aluminum trichloride.

l. Magnesium + Iodine

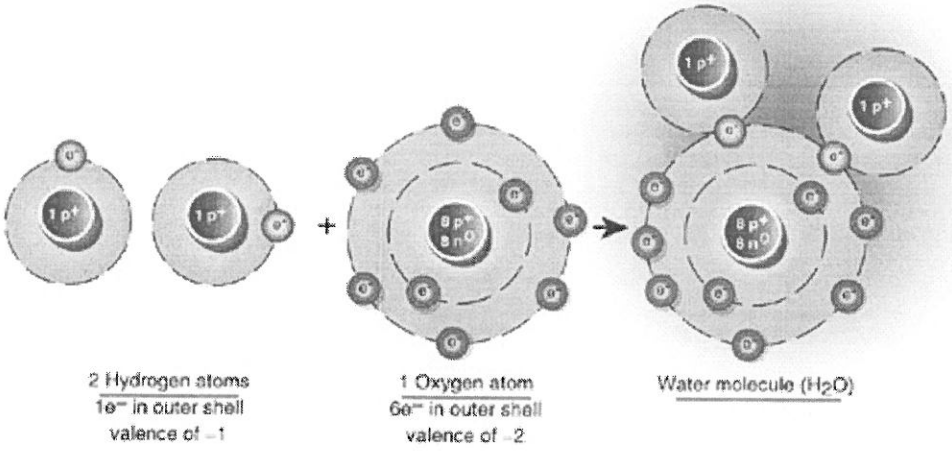


Formula $MgI_2$

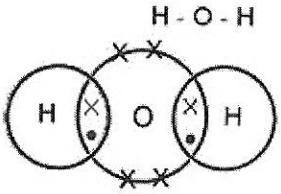
Name magnesium diiodide

## COVALENT BONDING

Covalent bonding involves the sharing of electron pairs between two atoms. This is most often between non-metal atoms (but there are a number of compounds between metals and non-metals that are covalent). A single covalent bond involves one shared pair of electrons. In many compounds, atoms will share electrons to enable their valence shell to become like the nearest Noble Gas. This is normally 8 electrons (the "Octet Rule"), apart from Hydrogen.




Structural diagram




### Chemical Bonding Practice

| | | |
|---|---|---|
| Ionic Bond | between a Metal and Non-Metal | (M + NM) |
| Covalent Bond | between a Non-Metal and Non-Metal | (NM + NM) |
| Metallic Bond | between a Metal and Metal | (M+ M) |

9. Determine if the elements in the following compounds are metals or non-metals. Describe the type of bonding that occurs in the compound.

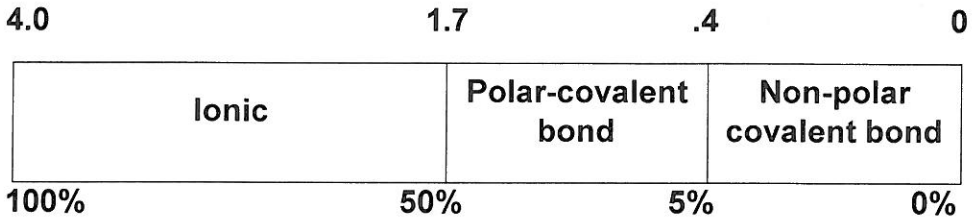
| Compound | Element 1 (metal or non-metal?) | Element 2 (metal or non-metal?) | Bond Type |
|---|---|---|---|
| $NO_2$ | N = non-metal | O = non-metal | covalent |
| NaCl | metal | non-metal | ionic |
| $SO_2$ | non-metal | non-metal | covalent |
| $PO_4^{3-}$ | non-metal | non-metal | Covalent (polyatomic ion) |
| $MgBr_2$ | metal | non-metal | ionic |

| | | | |
|---|---|---|---|
| CaO | metal | non-metal | ionic |
| $H_2O$ | non-metal | non-metal | covalent. |
| $K_2O$ | metal | non-metal | ionic. |
| Cu-Zn alloy | metal | metal | metallic. |
| $O_2$ | non-metal | non-metal | covalent. |
| $CuCl_2$ | metal | non-metal | covalent. |
| $NO_2^-$ | non-metal | non-metal | covalent (polyatomic ion) |
| $TiO_2$ | metal | nonmetal | ionic. |
| HF | non-metal | non-metal | covalent. |
| $Rb_2S$ | metal | non-metal | ionic. |
| Au-Ag mixture | metal | metal | metallic. |
| $Fe_2O_3$ | metal | non-metal | covalent. |

**Electronegativity:** A property of an atom which increases with its tendency to attract the electrons of a bond.

Examples: The chlorine atom has a higher electronegativity than the hydrogen atom, so the bonding electrons will be closer to the Cl than to the H in the HCl molecule.

**Difference in electronegativity**




**Percentage Ionic character**

**Electronegativity**

| 1A | 2A | | | | | | | | | | | 3A | 4A | 5A | 6A | 7A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | H 2.1 | | | | | | | | | |
| Li 1.0 | Be 1.5 | | | | | | | | | | | B 2.0 | C 2.5 | N 3.0 | O 3.5 | F 4.0 |
| Na 1.0 | Mg 1.2 | 3B | 4B | 5B | 6B | 7B | 8B | | | 1B | 2B | Al 1.5 | Si 1.8 | P 2.1 | S 2.5 | Cl 3.0 |
| K 0.9 | Ca 1.0 | Sc 1.3 | Ti 1.4 | V 1.5 | Cr 1.6 | Mn 1.6 | Fe 1.7 | Co 1.7 | Ni 1.8 | Cu 1.8 | Zn 1.6 | Ga 1.7 | Ge 1.9 | As 2.1 | Se 2.4 | Br 2.8 |
| Rb 0.9 | Sr 1.0 | Y 1.2 | Zr 1.3 | Nb 1.6 | Mo 1.6 | Tc 1.7 | Ru 1.8 | Rh 1.8 | Pd 1.8 | Ag 1.6 | Cd 1.6 | In 1.6 | Sn 1.8 | Sb 1.9 | Te 2.1 | I 2.5 |
| Cs 0.8 | Ba 1.0 | La 1.1 | Hf 1.3 | Ta 1.4 | W 1.5 | Re 1.7 | Os 1.9 | Ir 1.9 | Pt 1.8 | Au 1.9 | Hg 1.7 | Tl 1.6 | Pb 1.7 | Bi 1.8 | Po 1.9 | At 2.1 |

<1.0 | 1.0–1.4 | 1.5–1.9 | 2.0–2.4 | 2.5–2.9 | 3.0–3.9 | 4.0

| Bonding between | More electronegative element and value | Less electronegative element and value | Difference in electronegativity | Bond Type |
|---|---|---|---|---|
| Sulfur and Hydrogen | sulfur 2.5 | hydrogen 2.1 | 0.4 | NPC |
| Sulfur and cesium | sulfur 2.5 | cesium 0.8 | 1.7 | PC/I |
| Chlorine and bromine | chlorine 3.0 | bromine 2.8 | 0.2 | NPC |
| Calcium and chlorine | Chlorine 3.0 | calcium 1.0 | 2.0 | I |

| | | | | |
|---|---|---|---|---|
| Oxygen and hydrogen | Oxygen 3.5 | Hydrogen 2.1 | 1.4 | PC |
| Nitrogen and hydrogen | Nitrogen 3.0 | hydrogen 2.1 | 0.9 | PC |
| Iodine and iodine | Iodine 2.5 | | 0 | NPC |
| Copper and sulfur | Sulfur 2.5 | Copper 1.8 | 0.7 | PC |
| Hydrogen and fluorine | Fluorine 4.0 | hydrogen 2.1 | 1.9 | I |
| Carbon and oxygen | Oxygen 3.5 | Carbon 2.5 | 1.0 | PC. |

Molecular Geometries

Lone pair of non-bonding

| Shape | Electron arrangement[1] | Geometry[1] | Examples |
|---|---|---|---|
| Diatomic | | | HF, $O_2$ |
| Linear | | | $BeCl_2$, $HgCl_2$, $CO_2$ |
| Bent | | | $NO_2^-$, $SO_2$, $O_3$ |
| Bent | | | $H_2O$, $OF_2$ |
| Linear | | | $XeF_2$, $I_3^-$ |
| Trigonal planar | | | $BF_3$, $CO_3^{2-}$, $NO_3^-$, $SO_3$ |
| Trigonal pyramidal | | | $NH_3$, $PCl_3$ |
| T-shaped | | | $ClF_3$, $BrF_3$ |
| Tetrahedral | | | $CH_4$, $PO_4^{3-}$, $SO_4^{2-}$, $ClO_4^-$ |